FEB 23 '55A

Volume 41 February, 1955 *Number 2*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

New Developments
in
Farm Machinery

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

"Service Station" on wheels

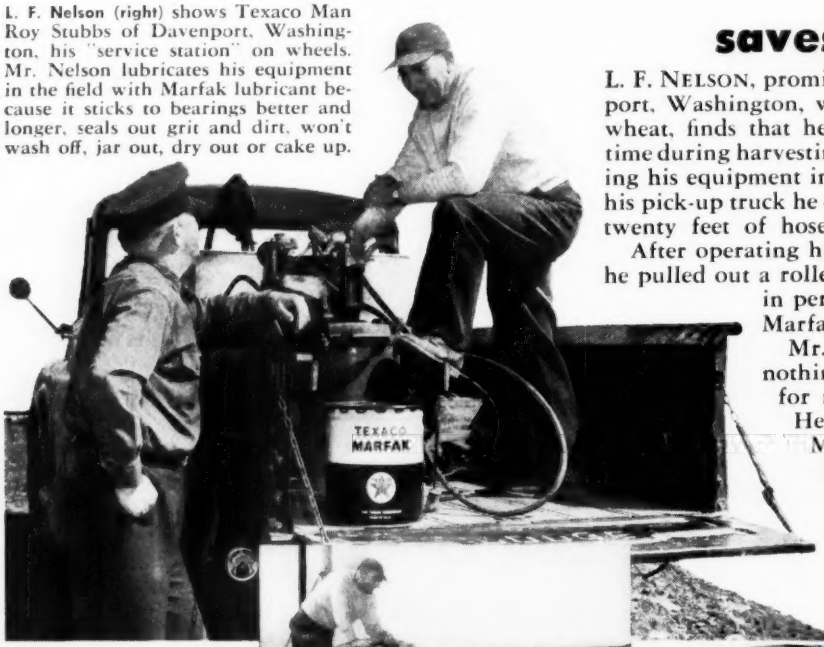
saves time

L. F. Nelson (right) shows Texaco Man Roy Stubbs of Davenport, Washington, his "service station" on wheels. Mr. Nelson lubricates his equipment in the field with Marfak lubricant because it sticks to bearings better and longer, seals out grit and dirt, won't wash off, jar out, dry out or cake up.

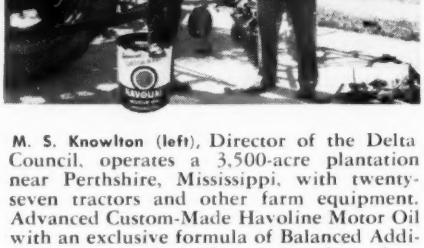
L. F. NELSON, prominent farmer near Davenport, Washington, who raises 1,500 acres of wheat, finds that he saves a lot of valuable time during harvesting operations by lubricating his equipment in the field. In the back of his pick-up truck he carries a compressor with twenty feet of hose and Marfak lubricant.

After operating his tractor for eight years, he pulled out a roller and found the bearing in perfect condition, thanks to Marfak lubricant.

Mr. Nelson has been using nothing but Texaco Products for more than twenty years. He uses Advanced Custom-Made Havoline and Ursa Heavy Duty Motor Oils, Universal Gear Lubricant EP, Diesel Chief, and Fire Chief Gasoline, besides Marfak.



Like Texaco Men the country over Roy Stubbs *(right)* gives on-time, neighborly service. Mr. Nelson is "filling up" his Caterpillar with Diesel Chief, the fuel that gives superior power in diesel motors, ensuring low-cost operation.



M. S. Knowlton (left), Director of the Delta Council, operates a 3,500-acre plantation near Perthshire, Mississippi, with twenty-seven tractors and other farm equipment. Advanced Custom-Made Havoline Motor Oil with an exclusive formula of Balanced Additives wear-proofs engines, keeps them clean and free from sludge, corrosion and rust. Texaco Man C. M. Shaw, Jr., Shelby, Mississippi *(right)*, serves Knowlton Plantation.

In town or on the highway, farmers and ranchers find Texaco Dealers give friendly, helpful service. Only Texaco Dealers have new top octane Sky Chief gasoline, Super-Charged with Petrox, to give maximum power and reduce engine wear... and famous Fire Chief, at regular prices, both 100% *Climate-Controlled* for top performance. You can also get Advanced Custom-Made Havoline, the motor oil that wear-proofs engines for longer life.

THE TEXAS COMPANY

TEXACO

ON FARM AND HIGHWAY IT PAYS TO USE TEXACO PRODUCTS

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by
The Texas Company, 135 East 42nd Street, New York 17, N. Y.
Copyright 1955 by The Texas Company
Copyright under International Copyright Convention. All Rights Reserved under Pan-American Copyright Convention.

J. S. Leach, Chairman of the Board of Directors; A. C. Long, President; R. F. Baker, Executive Vice President; M. Halpern, Senior Vice President; C. B. Barrett, G. R. Bryant, T. E. Buchanan, Stanley T. Crossland, Oscar John Dorwin, E. R. Filley, Robert Fisher, J. W. Foley, F. H. Holmes, A. N. Lilley, A. M. Ottignon, J. H. Pipkin, Torrey H. Webb, J. T. Wood, Jr., J. S. Worden, Vice Presidents;
W. G. Elicker, Secretary; E. C. Breeding, Comptroller.

Vol. XLI February, 1955 No. 2

Change of Address: In reporting change of address kindly give both old and new addresses.
"The contents of 'LUBRICATION' are copyrighted and cannot be reprinted by other publications without written approval and then only provided the article is quoted exactly and credit given to THE TEXAS COMPANY."

New Developments in Farm Machinery

DEVELOPMENTS in farming during the last half century certainly rank among the foremost of those many and varied factors which have contributed to our current high standard of living. This is particularly noteworthy since it has been only in comparatively recent years that any significant progress has been made in farming methods or equipment. The farmers of ancient Egypt, Greece, Rome and Syria established certain agricultural practices which were improved upon only slightly in the centuries that followed. Even the Industrial Revolution did little to lighten the farmer's task or increase his productivity.

Progress in all phases of farming has paralleled advancements in the field of mobile power. Some improvement occurred about a thousand years ago when the horse was introduced to replace or supplement oxen. However, it remained for the steam engine and later the gasoline and Diesel engines to free the farmer from the close and burdensome ties associated with tilling, planting, cultivating and harvesting. Today approximately 35 horsepower is available to each farm worker. Thus it is no wonder that 15 per cent of the working forces can produce enough food and fiber to satisfy the needs of all of our people.

The early steam tractors were heavy, awkward, and of limited utility, and it was up to the designing engineers to make them useful under more varied service conditions. There were many avenues of approach which included decreasing overall weight, increasing available horsepower, increasing vehicle speed and making power available to drawn and mounted implements. The use of gasoline and Diesel engines was a big step in reducing the weight and at the same time increasing the horsepower available to the operator. By equipping the machines with rubber tires, speeds were increased and tasks could be completed in three-quarters to one-half the time that was formerly required. The power take-off supplied power for operating drawn, mounted or stationary equipment.

TRACTORS

Higher compressions are being used for engines which utilize either gasoline or LPG (liquefied petroleum gas) as fuel. This trend, so noticeable in the passenger car field, is being reflected now in the agricultural field. The compression ratios are not yet as high in the farm engines, but they are definitely moving up; compression ratios of 6.5-7:1 are now common for tractor gasoline engines. As a result, regular grade gasolines are required to secure the performance built into the engine. Diesel engines employ the principle of high compression to reach autogenous ignition temperatures, and of course must use a fuel designed for them.

One farm equipment manufacturer designed and built an experimental engine to explore some of the problems and possibilities that would be associated

TABLE I
XO-121 SPECIFICATIONS

Number of Cylinders	4
Cylinder-Head Type	Overhead Valve
Bore and Stroke	3.75 x 4.5 In.
Displacement	198.8 Cu. In.
Governed Speed	1600 RPM
Compression Ratios (3 different heads)	7:1, 9.5:1, 12:1
Ignition System	12 Volt
Crankshaft	Five Main Bearings
Main Journal Dia.	3.00 In.
Crankpin Diameter	2.31 In.

with high brake thermal efficiency and high horsepower per cubic inch displacement. While it must be remembered that this engine is experimental and is not available now or contemplated in the immediate future, some of the results obtained are very informative and encouraging. The general specifications are shown in Table I.

Brake horsepower and specific fuel consumption under full load were determined as compression ratio was varied between 7:1 and 12:1. The spark and carburetor were adjusted for maximum performance under each different condition of speed and compression. The power and economy curves using a 19 mm carburetor venturi, at speeds up to 1600 RPM, are shown in Figure (1). Figure (2) shows the full load power and economy values obtained using a 21 mm carburetor venturi at speeds from 1600 to 2400 RPM. It may be noted that there are impressive gains in power at the higher RPM at the expense of very small losses in specific fuel consumption.

As interesting as these values are, however, it must be realized that there are many factors which must be considered in designing a new engine. The designer must bear in mind the octane requirements of such an engine so that the fuels required will be available in commercial quantities. The anti-knock requirements of the experimental engine at 12:1 compression ratio and low RPM are very high, calling for a fuel equivalent to iso-octane containing 3.75 ml of TEL/gal. These requirements are shown in Figure (3). The requirement is reduced for all compression ratios as speed is increased. At compression ratios of 9.5:1 and 7:1 the engine could be operated on fuels available commercially today. By accepting a small power loss, today's fuels could be used over a rather wide speed range as shown in Figure (4). It thus appears that by applying present day automotive engine design, it is possible to produce engines for tractors that will make full use of available fuels with no operational handicaps. The compression ratios of such engines could be raised to provide additional performance as fuels of even higher octanes reach the market.

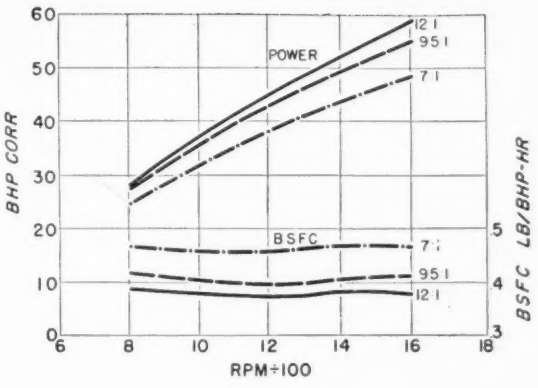
Returning from an exploration of what might be, we find that small changes are occurring continually. To mention a few, combustion chambers are changed by either head or piston variations; valves through improved metallurgy have better steels and their life has been lengthened through the use of rotators; valve guides may be given a new look; spark plugs are more versatile; bearings are precision manufactured to carry greater loads with less susceptibility to fatigue and greater resistance to corrosion. Indeed, such advances in the aggregate contribute very effectively to the farmer's continual demand for more power at no increase in equipment weight or cost.

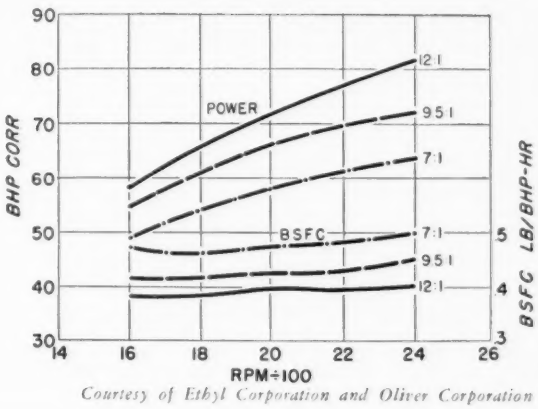
Power Take-offs

Having once achieved a satisfactory power plant and a vehicle that could pull drawn implements, a demand arose to make the power available for doing other useful work. This first took the form of working through belt pulleys, but it was not long before a *power take-off shaft* was added. In many respects this laid the foundation for modern implements. One of the initial drawbacks was the fact that there was not enough independence between the speed of the vehicle and the operating speed of the PTO shaft. To remedy this, several methods have evolved which permit the speed of the PTO to be regulated independently of the speed of the vehicle. Three types of power take-off have emerged, namely, through the transmission, constant running and independent.

One manufacturer has answered the problem through the use of two clutches. One clutch controls tractor travel, but an attached unit may continue to operate since the power transmission from the engine has not been interrupted. The second clutch controls the flow of all power including an attached implement. This system is shown in Figure (5) and is an example of a continuous running PTO.

Another manufacturer has achieved the objective of independent vehicle and PTO speed through a type of unit known throughout the industry as an independent PTO. In this unit the power is taken from a gear splined to the engine clutch pressure plate to a gear which in turn is splined (yet may be independently disconnected) to a shaft which runs through the transmission by way of a hollow countershaft as shown in Figures (6) and (6a). This shaft is connected to a ring gear which operates





Courtesy of Ethyl Corporation and Oliver Corporation

Figures 1 and 2 — Information on power and economy developed under full load conditions.

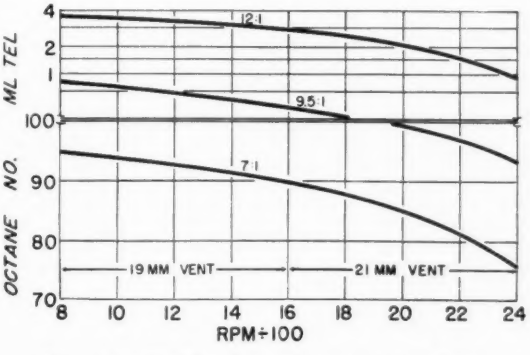
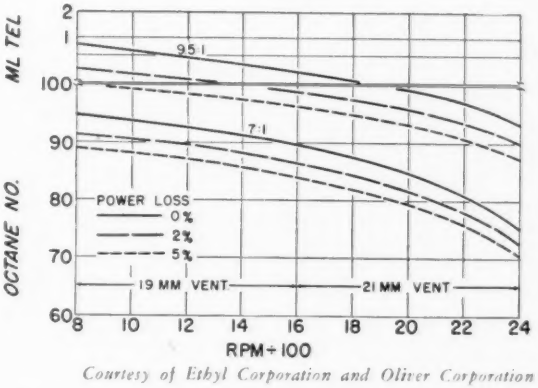
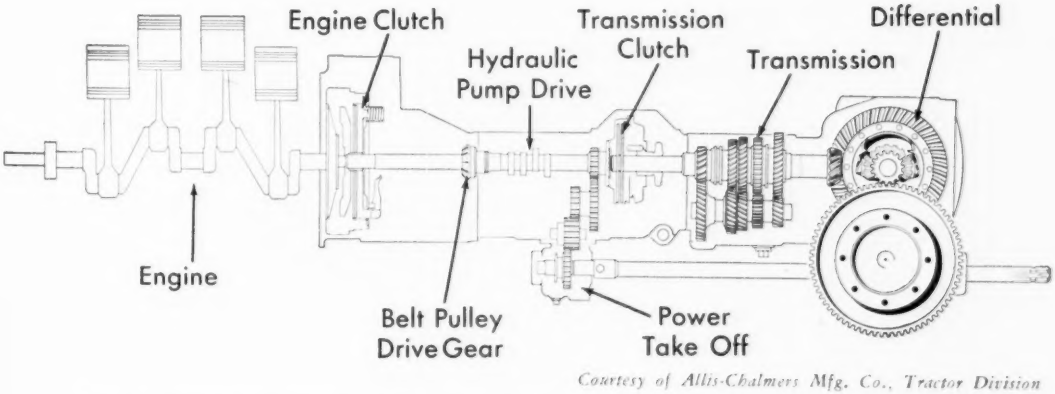


Figure 3 — Anti knock requirements at maximum power spark timing.



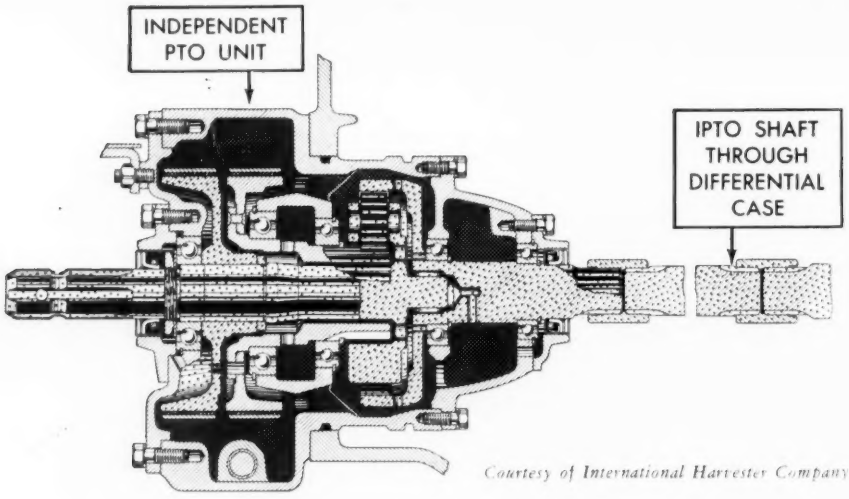
Courtesy of Ethyl Corporation and Oliver Corporation

Figure 4 — At slightly retarded spark settings octane requirements may be reduced with relatively small power losses.



Courtesy of Allis-Chalmers Mfg. Co., Tractor Division

Figure 5 — Power train showing relative position of the two clutches used with constant running PTO.



Courtesy of International Harvester Company

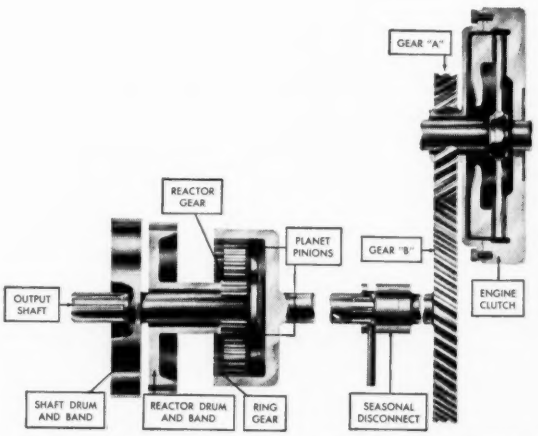
Figure 6a — Details of independent PTO.

through a planetary gear set. Bands control the output. The power flow may be followed in Figure (7).

When the PTO shaft is operating, the brake band on the shaft drum is released and the band on the reactor drum is applied. The reactor gear is held stationary and the ring gear turns the planetary pinions around the reactor gear. The planetary pinions, which are mounted to the PTO shaft, cause it to turn. When the PTO is not in operation, brake pressure is applied to the shaft drum and released on the reactor drum. The ring gear thus drives through the planetary pinions which serve as idlers.

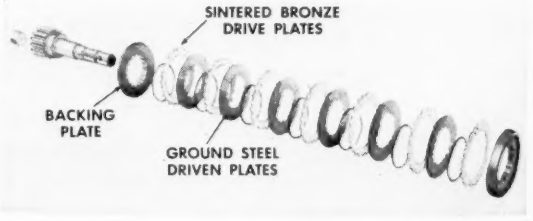
A careful study of Figure (9) will show also that provision is made for speed regulation or torque variation through a unit consisting of a disc clutch, a planetary gear set with carrier, and a cam-roller over-running clutch. With this unit two speeds (or two torques) are available for every gear speed normally available through the transmission. In these units one may see the increasing use of ball, roller or needle bearings.

The importance of the clutch should not be overlooked since it controls the flow of power. An instance of the thought, effort and frustration that accompanies new developments is exemplified in a case that actually occurred in the manufacture of a clutch. The unit as originally designed had a chatter that was undesirable and modifications were necessary. Before a satisfactory unit emerged, over twenty changes in metallurgy and configuration were explored. The new unit proved to operate most effectively on a petroleum product that in the not too distant past would have been considered a special product. However, the development in the automotive field of an automatic transmission,



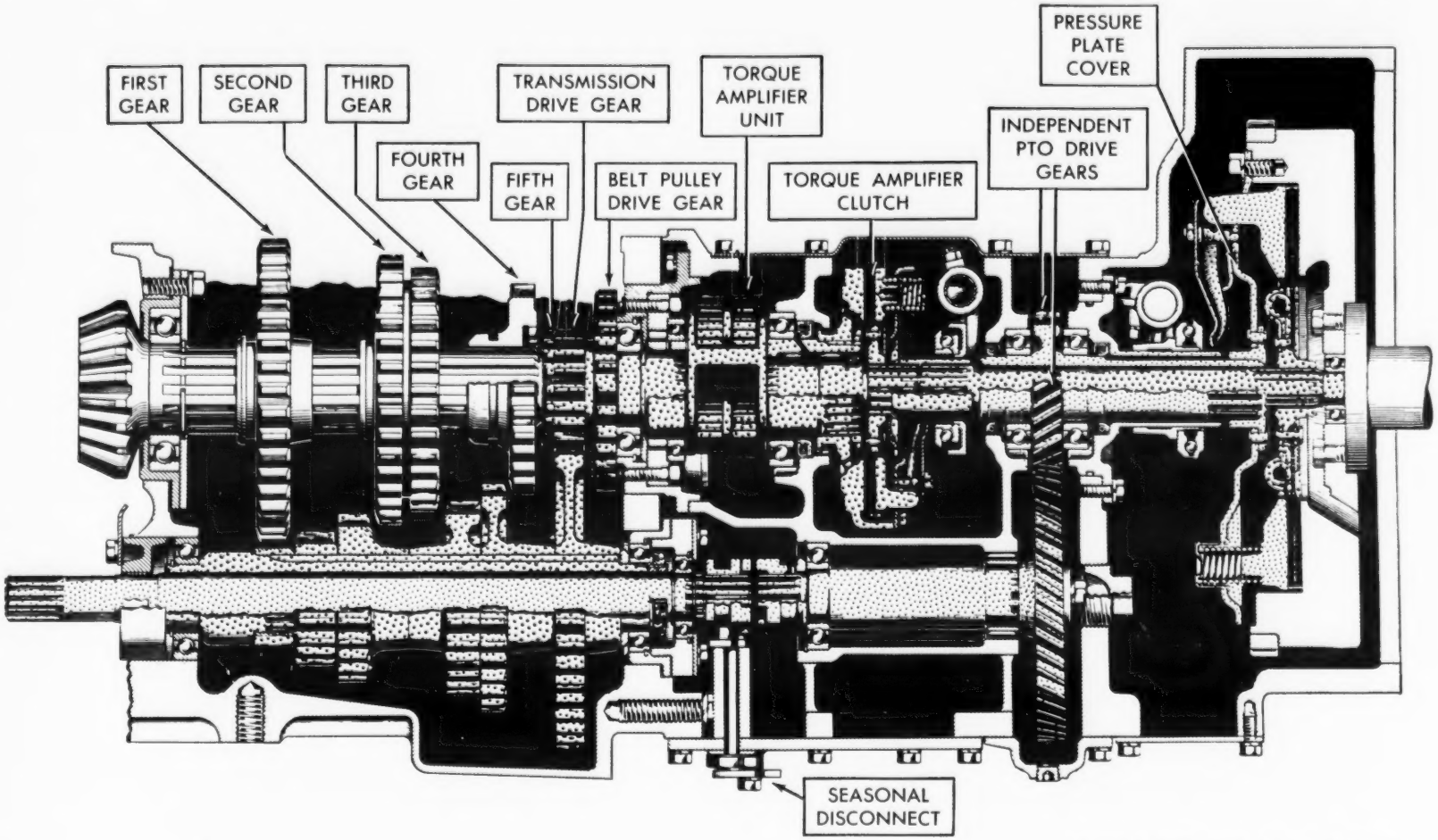
Courtesy of International Harvester Company

Figure 7 — Gears A and B are independent PTO drive gears and flow of power may be followed to output shaft.



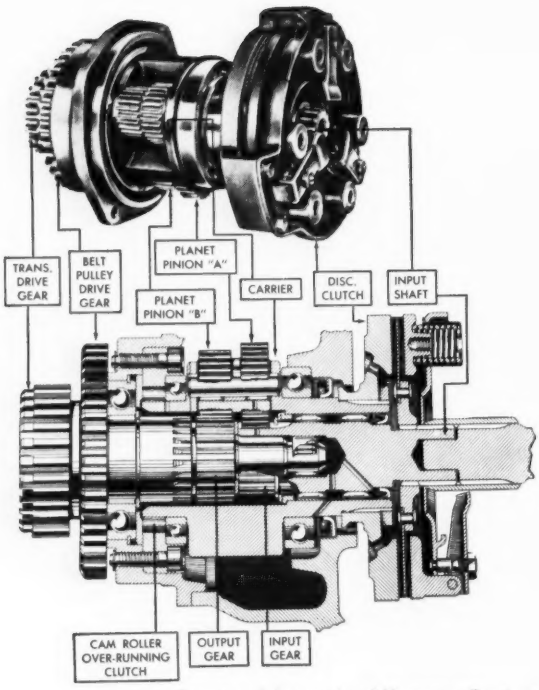
Courtesy of J. I. Case

Figure 8 — View of clutch assembly.



Courtesy of International Harvester Company

Figure 6 — Power flow through torque amplifier (darker shading) and into the transmission. Power flow to independent power take off is also shown (lighter shading).



Courtesy of International Harvester Company

Figure 9 — Actual view and cross section of torque amplifier. The disc clutch operates within a dry compartment of the tractor clutch housing. The rest of unit is lubricated from the oil in the main transmission.

using plates of similar construction and material, had led to the development of a special petroleum product. It was found that this automatic transmission fluid could be used in the clutch with excellent results and was readily available in commercial quantities.

The discussion above indicates the approach taken by several farm equipment manufacturers to the problem of take-off units. It must be realized that these approaches do not cover the entire field and there is no intention of implying that these are necessarily the best way of answering the problem. The important point is that power take-off speeds and tractor speeds can be varied independently.

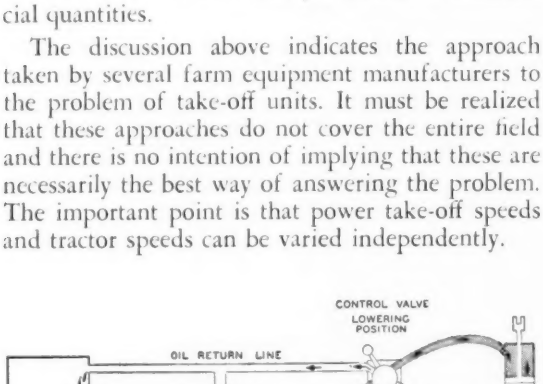
Hydraulic Systems

The use of fluids for hydraulic control constantly is proving its worth in the agricultural field. While the development of each component in the tractor itself has contributed greatly to the present vehicle, it remained for hydraulics with the immediate, positive, accurate, and smooth control of power, combined with attractive economics and simplicity of construction, to bring tractors to their present state of utility.

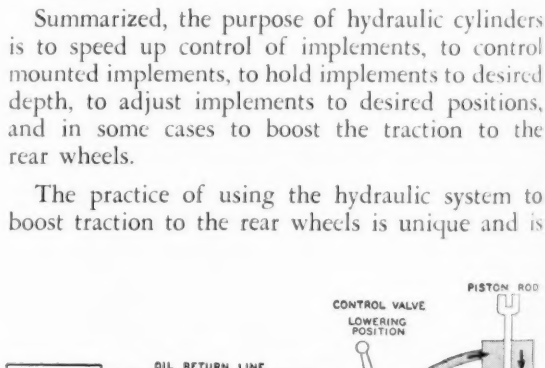
The basic parts of a hydraulic system consist of reservoir, pump, control valve and cylinder. Schematic single and double valve control systems are shown in Figure (10). The reservoir must be sufficiently large to hold and supply hydraulic fluid to the entire system at all times. In addition the reservoir acts to effect air, dirt and water separation from the hydraulic fluid. Last but not least, heat which has been generated in the system must be dissipated at this point. The pump and drive may and do vary to suit best the requirements of the various tractor manufacturers. The control valves may also vary but all have three essential duties: to direct flow, to control pressure, and to control volume. Wide variation within these three spheres of duty are available to the manufacturer. Therefore, each manufacturer has adopted for his tractor a hydraulic system which is most suitable for his purpose. Standards have been agreed upon within the American Society of Agricultural Engineers and the Society of Automotive Engineers regarding hydraulic remote control cylinders. No matter which tractor is purchased as the basic unit, it will serve as a power source for implements of other manufacture.

Summarized, the purpose of hydraulic cylinders is to speed up control of implements, to control mounted implements, to hold implements to desired depth, to adjust implements to desired positions, and in some cases to boost the traction to the rear wheels.

The practice of using the hydraulic system to boost traction to the rear wheels is unique and is



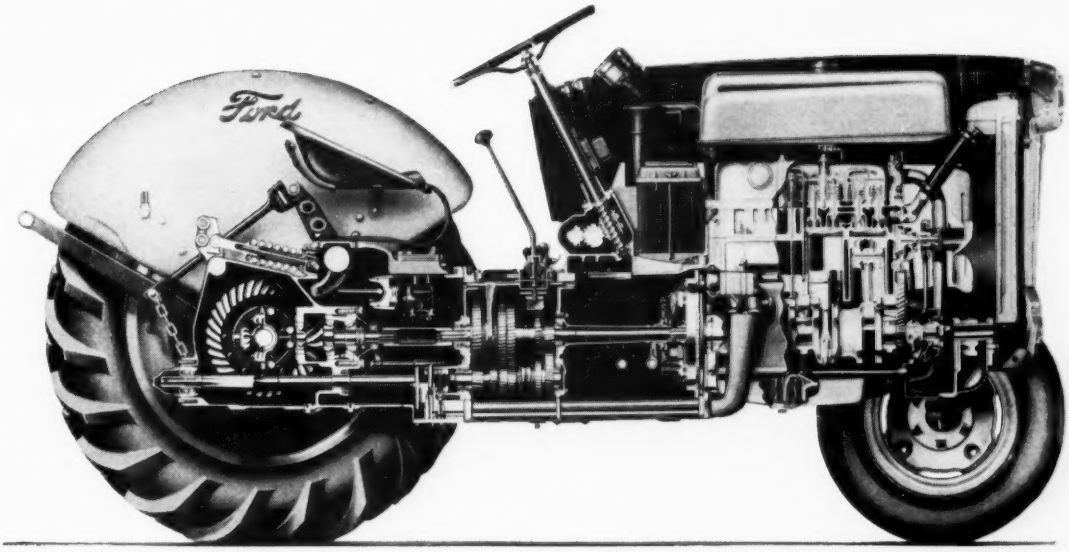
Double



Courtesy of J. I. Case Company

Single

Figure 10 — Schematic of single and double valve hydraulic control system.



Courtesy of Tractor and Implement Division, Ford Motor Company

Figure 11 — Cutaway of new model tractor. Double clutch assembly permits PTO to operate independent of tractor movement.

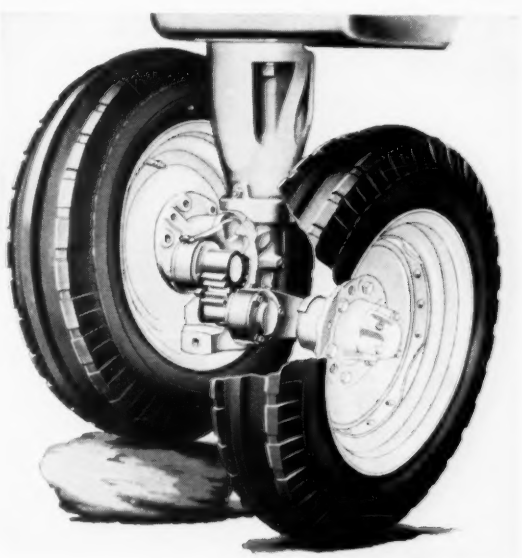
possible only because a single point hitch is used between the implement and the tractor. This application, in effect, permits the transfer of part of the weight of the implement to the rear wheels of the tractor. The hydraulic cylinder applies a lifting force on the implement within the range of the automatic control, but not enough to raise it. This force is thereby transferred to the rear wheels and is regulated by the draft impulse registered against a pre-loaded spring at the hitching point, according to the resistance of the implement against the soil.

Steering

Steering and front end design in a tractor are important. A unit which is hard to steer, or passes back a shock, tires the farmer unduly. The use of forward mounted implements places an even greater premium on easy steering. It thus appears that power steering as a transfer from the automotive field has a ready made market and opens the way for even further use of forward mounted tools.

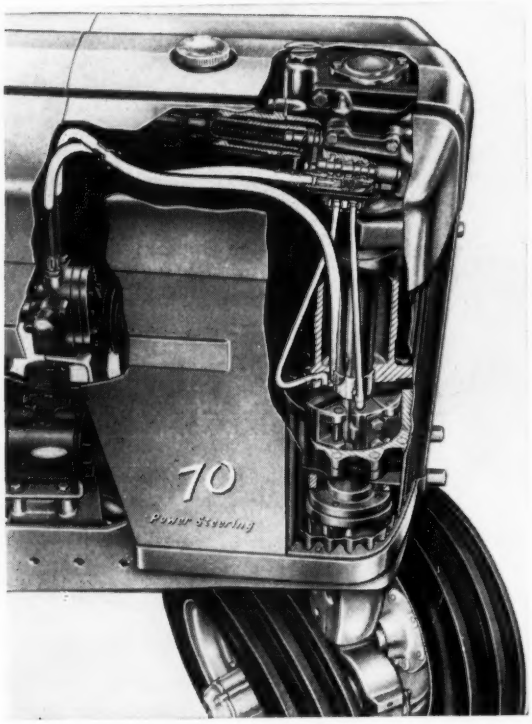
One manufacturer offers a front wheel system as shown in Figure (12) to reduce the amount of front end bounce. In this system, up or down movement in one wheel is transferred through the gears to equalize automatically the load on both wheels. In addition, up and down movement of the front end is cut in half as the tractor travels over rough ground. To better realize the importance of front end geometry it can be pointed out that as many as six variations of front wheel assemblies may be available to meet specific conditions.

Several types of power steering such as electrical, mechanical, pneumatic, or hydraulic are available in other fields, but the hydraulic type is a natural for the agricultural field. There are two variations of the hydraulic type which have the most attraction: (1) the linkage type, which is actuated through power applied to a hydraulic cylinder attached to the tie rods or drag links and which is controlled by a valve in the linkage and (2) the integral type where the hydraulic cylinder is attached



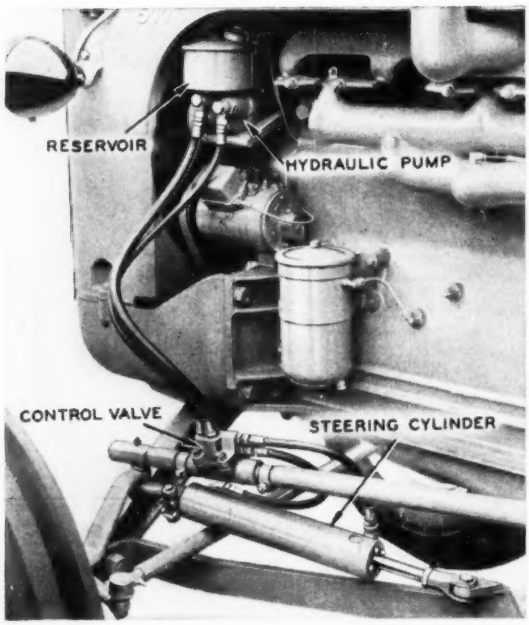
Courtesy of Deere and Co.

Figure 12 — Design to reduce front end motion. Field obstruction has raised one wheel, forcing other down and equalizing load.



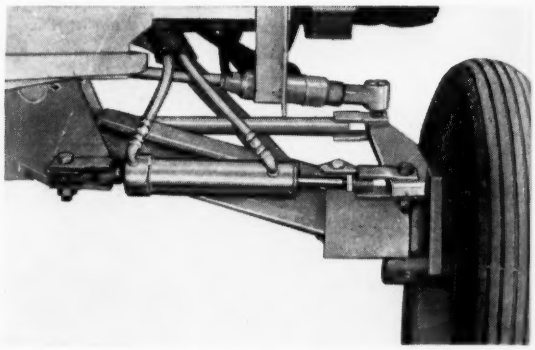
Courtesy of Deere and Co.

Figure 13 — Steering cylinder and mounting.



Courtesy of J. I. Case Company

Figure 14 — Linkage type of hydraulic steering.



Courtesy of Minneapolis-Moline Company

Figure 15 — Another mounting for linkage type of hydraulic steering.

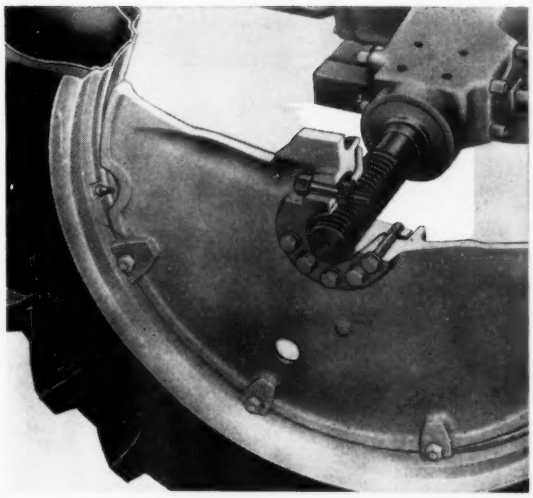
to the steering housing and power applied to the Pitman shaft is controlled by a valve mounted adjacent to or within the housing.

One manufacturer in approaching this problem decided on the integral type of construction, but employed a vane type hydraulic cylinder for the ram type normally employed. In this unit, Figure (13), there is full capacity in all positions. Torque is transmitted through a minimum of structural members and there is no difficulty in securing rotation for full turns in either direction. The steering cylinder unit mounted directly above the front wheels consists of a stationary vane anchored to the housing and a moveable vane attached to the steering spindle. Pressure acting between the moveable and stationary vanes creates torque on the steering spindle. This pressure can be applied to either side of the movable vane providing power on turns in either direction. The heart of this system is contained in the valve and associated actuating mechanism mounted at the top of the steering spindle near the steering worm. Fluid flow, provided by a gear type pump at pressures up to 200 pounds psi, is constant and independent of engine speed. Steering feel of four to five pounds is provided by a spring inside the valve actuating sleeve acting against a cam. Mechanical control remains at all times.

Power steering provided by other manufacturers at this time is of the linkage type. The February, 1953 issue of LUBRICATION is devoted to power steering as it is applied to passenger cars and includes a section on the linkage type of power steering.

Rear Wheels

When it is borne in mind that a rear wheel of a general purpose tractor may weigh from 500 to 1000 pounds, safety as well as convenience demands that consideration be given to the method



Courtesy of Deere and Co.

Figure 16 — Loosening clamp screws and tightening jack screws frees wheel; adjusting nut and gear move wheel to desired position.

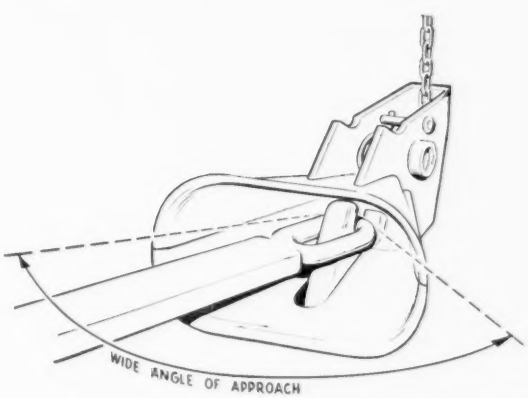
Courtesy of Allis-Chalmers Mfg. Co., Tractor Division

Figure 17 — Rails on wheel rim permit wheel spacing to be altered by utilizing power of tractor.

of adjusting these wheels for different row spacing. Three approaches have been made to this problem. The first employs the hydraulic system of the tractor. A large block placed under the hitch raises the wheel as hydraulic power is applied. The wheel is then spread to the correct spacing on the axle and tightened. The second system jacks the wheel either mechanically or hydraulically, then three clamp screws which hold the wheel in position are loosened and two jack screws which free the wheel on the axle are tightened. An adjusting nut attached to a small gear is used to move the wheel in and out on the axle. Once positioned, the wheel is locked by loosening the jack screws and tightening the clamp screws. This system of wheel adjustment is shown in Figure (16). The third system uses power from the engine to achieve wheel adjustment without the use of a jack or other lifting device. In this system four eccentrics on each wheel are loosened, the tractor is placed in gear, and the throttle is opened. The wheels move in or out on spiral bars or guides built into the rims. The action is much like a wing nut following the threads of a bolt. (See Figure 17). Each wheel has four spaced increments of two and one-half inches. The wheel is locked in a new position by tightening the eccentrics. This system may be employed on those tractors having clearance achieved through the use of a "stub" axle.

Hitches

Previously it has been noted that the type of hitch may influence some feature or performance of the tractor. Since this is so, let us look briefly at the three types of hitches, namely the single point, the two point, and the three point. The single point hitch, shown in Figure (18) is the simplest and, is used for rear mounted tools. Lift links may be incorporated on the implement to facilitate transportation. Although the two point hitch is normally associated with rear attached implements, a two point hitch is also used on some of the newer side mounted implements. This hitch may take the form of a yoke with a socket on each end suspended as shown in Figure (19). In this system the yoke replaces the draw bar and attaching brackets and can be positioned hydraulically in three directions — horizontally, vertically and diagonally. The three point hitch, perhaps more common than either of the other two at this time, is designed primarily to permit control of maneuverability in close quarters and transportation from area to area. The upper hitch point provides lateral and vertical flexibility; the lower points control side to side as well as fore and aft leveling.

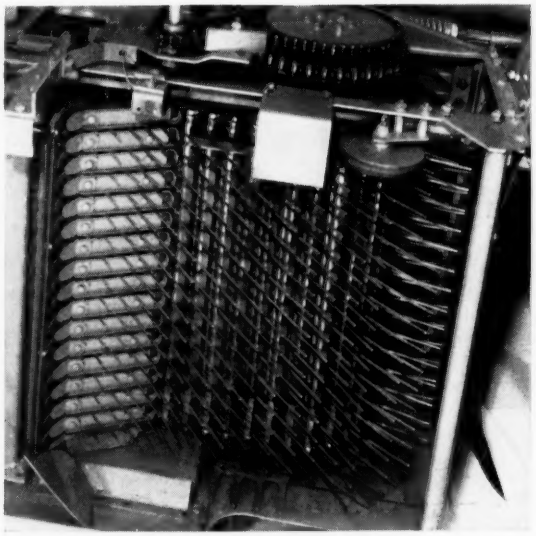


Courtesy of Allis-Chalmers Mfg. Co., Tractor Division

Figure 18 — Single point hitch.

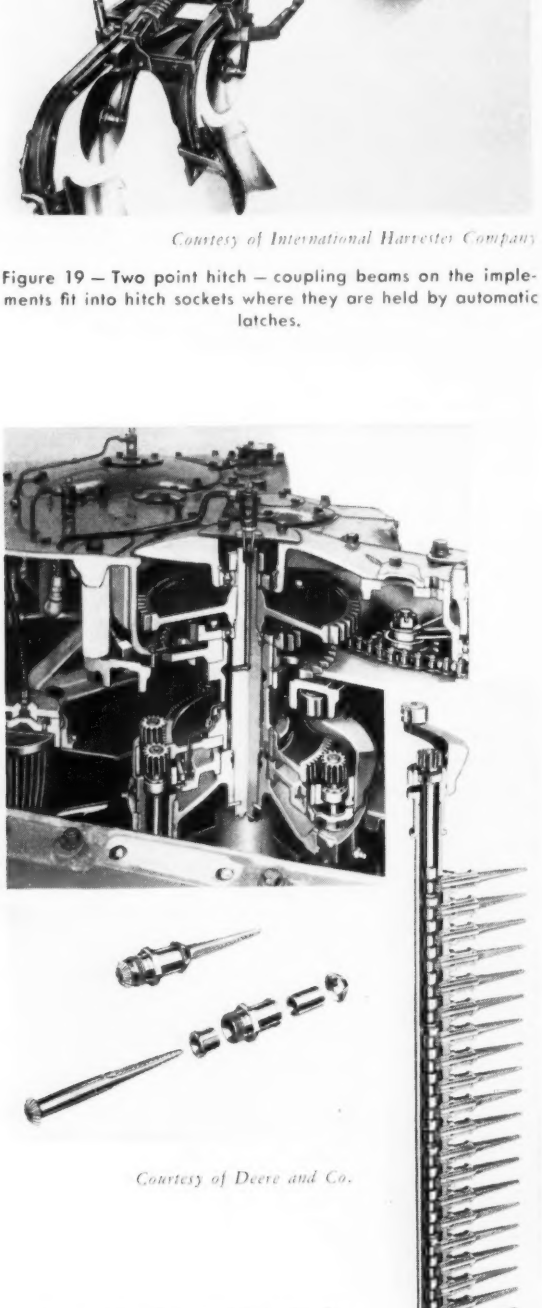
Courtesy of International Harvester Company

Figure 19 — Two point hitch — coupling beams on the implements fit into hitch sockets where they are held by automatic latches.



Courtesy of Allis-Chalmers Mfg. Co., Tractor Division

Figure 21 — Spindles of cotton picker passing through stripper section shown at left.



Courtesy of Deere and Co.

Figure 20 — Cotton picker showing assembly of spindles, picker bar, and picking unit head.

SELF-PROPELLED VEHICLES

Self-propelled vehicles are limited in number but have proven indispensable when the size of the crop warrants such a specialized machine. Combines and cotton pickers are prime examples.

Self-propelled combines have been manufactured for some time and they are continually being improved. Most of them now incorporate some type of power steering, and since they often are required to operate in hilly terrain, they have a low center of gravity and a very wide wheel base. Hydraulic controls have been incorporated on all of the newer models to ease the work of the operators. In one unit, self-leveling has been incorporated which automatically levels the unit on grades up to 37 per cent. The unit of another manufacturer has incorporated a variable speed hydraulic drive unit in the power train. This variable drive unit houses a set of three planetary gear pumps and a single large sun gear on an output shaft. The main housing which serves as an oil reservoir has large fins which provide ample cooling. This housing rotates with the input power sheave to rotate the pump gears. The amount of oil admitted to these gears is regulated by the operator's control valve. The unit protects the implement by absorbing shocks and overloads occurring between the engine and the transmission.

Cotton pickers are definitely making a name for themselves in the cotton producing areas. Difficulty was encountered with the early machines, but most of the "bugs" have now been eliminated and two row units can pick up to one and three-quarters acres of cotton per hour. A cutaway of the gearing

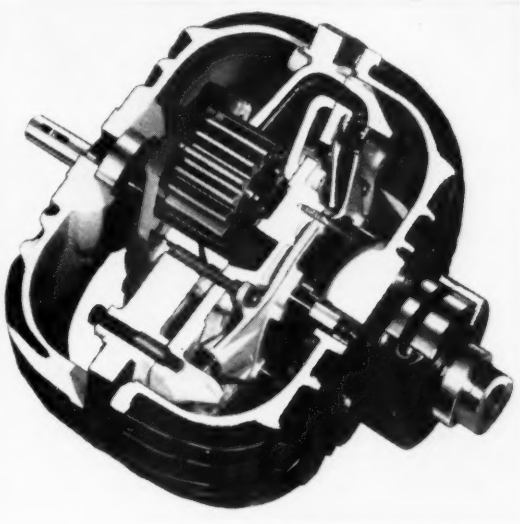
and picker bar is shown in Figure (20). The assembly in the stripper area is shown in Figure (21).

Most self-propelled implements are designed for a specific operation. The cotton picker, for instance, performs the one task of picking cotton. The combine harvests grain or seed crops. Even these machines, however, are now being manufactured to perform more than one task. One manufacturer provides a corn attachment for the combine's regular grain platform which permits the operator to pick and shell corn in the field.

MOUNTED IMPLEMENTS

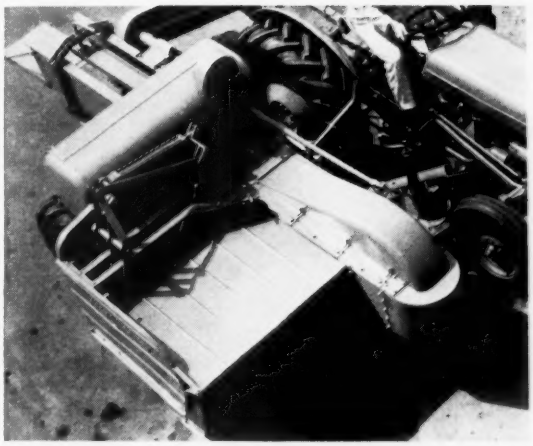
The first cousins to the self-propelled implement are the mounted implements. These are implements which are mounted on or carried by the tractor and depend on it for power to operate essential assemblies within the implement. They are a natural development following the desire of the farmers for more versatility. Such units generally fall within the harvesting group and their particular advantage arises from the elimination of duplicate power plants that perform useful tasks for a very small proportion of the year.

One manufacturer in approaching this idea designed a special tractor to which five other harvesting units could be attached. The tractor unit is of a tri-cycle type with a cross-mounted engine and rear steering. Variable speed sheaves are used to permit variable tractor speed while the harvesting speed remains steady. Hydraulic control is incorporated in the form of an engine driven hydraulic pump. The five harvesting implements include a forager, a harvester, a corn picker and husker, a corn picker and sheller, and a windrower. Each of the implements is designed specifically for use only with the tractor. Such attachments can not be used interchangeably with tractors of other manufacture.



Courtesy of Minneapolis-Moline Company

Figure 22 — Variable speed unit incorporated in power train of self propelled implements to absorb shocks and overloads.

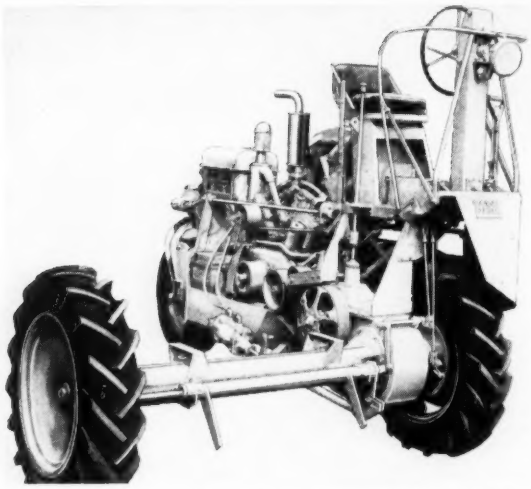


Courtesy of Ferguson Division, Massey-Harris-Ferguson, Inc.

Figure 23 — Mounted Baler with two point hitch, power delivered through power take-off.

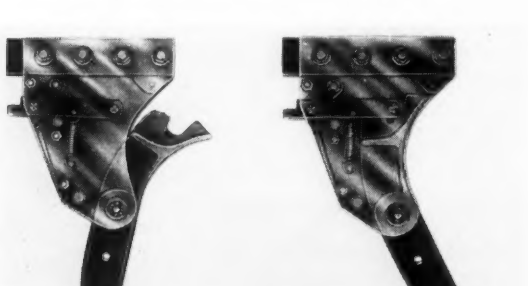
Another manufacturer has approached the problem believing that modern harvesting implements should be used by integrating the standard tractor and the mounted implement. In this case the implement is side mounted and all of the important advantages of a self-propelled unit are again secured. Three implements are available for use with the standard tractor, a forager, a subsoiler and a baler. Balers are not normally considered self-propelled but the good maneuverability and intimate control of the combined unit lets this combination fulfill the requirement. Such a unit is shown in Figure (23). It may be of interest that this baler can be converted from twine tie to a wire twist as requirements indicate. Two power options are offered, either through a drive shaft attached to the tractor power take-off (normal conditions) or through an auxiliary portable engine designed and available for use with the implements (unusual conditions). If the second alternative is selected, the auxiliary engine may be hydraulically lifted by the tractor for mounting, removal or transportation. An outboard wheel drive assembly is optional for added traction in punishing terrain.

It is possible that the advantages of mounted implements with the elimination of duplication are worthwhile and sufficient in themselves. However, since time is of the essence on the farm, it is also the objective of the manufacturer to make hitching and unhitching as speedy as possible. It is reported that these operations can be accomplished in as little as two minutes with this type of unit.



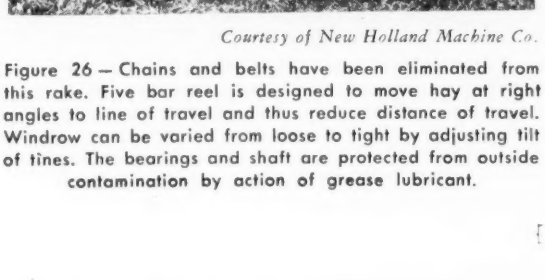
Courtesy of Minneapolis-Moline Company

Figure 24 — Tricycle type tractor with rear steering, designed for use with a variety of mounted implements.



Courtesy of Deere and Co.

Figure 25 — Tipping type of plow offers protection if obstruction is encountered.



Courtesy of New Holland Machine Co.

Figure 26 — Chains and belts have been eliminated from this rake. Five bar reel is designed to move hay at right angles to line of travel and thus reduce distance of travel. Windrow can be varied from loose to tight by adjusting tilt of tines. The bearings and shaft are protected from outside contamination by action of grease lubricant.

IMPLEMENTS

Up to this point we have considered new developments associated with tractors, self-propelled and mounted implements. It must not be concluded that improvements have been overlooked in other farm tools.

As an example, trips have been introduced on plows to prevent damage if the plow bottom strikes a solid obstruction. The plow may be reset by backing the tractor without raising the plow or changing the adjustment (see Figure 25).

One of the earliest implements from a historical point of view is the mower. Figure (27) illustrates a recent innovation in the power train associated with this implement. The cutter bar has been attached to a lever, which is driven from a crankshaft and connecting rod type of assembly, imparting reciprocal motion. In this assembly it was necessary to install special bearings to give the desired type of performance.

In the case of one corn picker, much greater use is made of gears. The number of chains normally associated with this type of unit has been reduced until only five are required for the entire picker — two heavy duty gatherer chains, a single main conveyor chain, a main power drive chain, and a link chain for the wagon elevator. In this unit, with the exception of the roller chain main power drive, all component parts are driven through enclosed hardened cut steel gears.

The above examples do not by any means include all the new developments that have occurred, and are suggested only as examples.

PETROLEUM PRODUCTS

Fuels

Three types of fuels are commonly used on the farm — LPG, gasoline and Diesel fuel. Tractor fuel in the past was a very popular product, but its importance is declining.

Liquefied petroleum gas (LPG) is used mostly in areas that are relatively near oil and gas fields or gas pipelines. This fuel is composed of the lighter gases, predominantly propane and propylene that are liquid under rather moderate pressures. Analyses of LPG products are shown in Table 2. It should be remembered that there is considerable variation in the composition of such products as shown in the tabulation.

In areas where LPG is used as a tractor fuel, it is usually used in other applications around the farm. In such cases, the cost of installation of the storage tank, which is rather high, can be more easily justified. To realize full benefits from LPG as an engine fuel, the engine must be modified. This modification may be made by the manufacturer

TABLE II
COMMERCIAL LPG

C-2 Ethane, Mol., %		1.3	1.7
C-3 Propane, Mol., %	59.1	77.6	91.2
C-3 Propylene, Mol., %	39.6	18.8	5.1
C-4 Butane, Mol., %	1.3	2.1	2.0
C-4 Butylene, Mol., %		0.2	.

before the tractor leaves the factory, or may be done by the operator using a kit. The preference for LPG as a fuel appears to vary directly with the distance of the farm from the oil and gas fields.

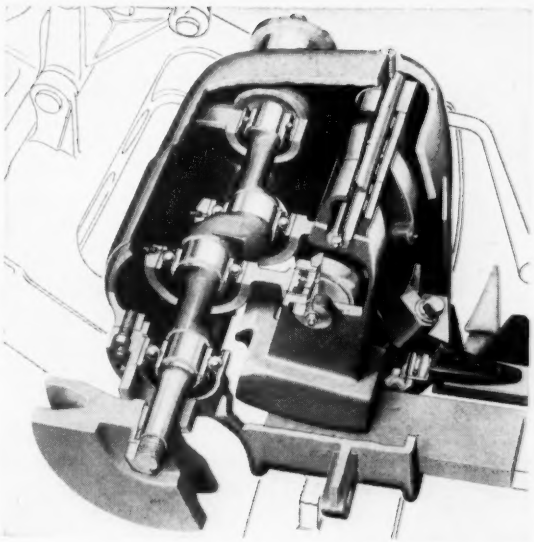
LPG can be a very satisfactory fuel from both a performance and economic standpoint. It is clean burning and does not dilute the lubricant. Some early work indicated that LPG might be corrosive to bearings and it was suggested that its composition might be responsible. However, further work has shown that the air/fuel ratio is more critical. Rich mixtures should not be used for any extended period of operation.

Gasoline is the most widely used fuel on the farm. It is only recently, however, that regular grade gasoline has been required and recommended. This change from third grade gasoline has been due to the use of the higher compression engines now powering the tractors. The secondary and minor influence may be due to the fact that the farmer's car requires at least a regular gasoline and since a common storage tank is usual, it is now desirable for the manufacturer to recommend such fuels. Early in the article it was noted that the manufacturers are aware of the advantages in using higher compression ratios and with these ratios higher octane gasolines will be required.

On the larger farms and in specialized cases, Diesel engines have found a very favorable market. The fuels required by these engines are widely available and of good quality. Most of these engines use a No. 2 Diesel fuel. The very broad requirements established by the American Society of Testing Materials for all grades of Diesel fuel are shown in Table 3.

Lubricants

The American Petroleum Institute and the Society of Automotive Engineers formerly recognized three grades of engine oil lubricants – Regular, Premium and Heavy Duty. Recently, however, these classifications were changed so that engine oil recommendations would be made based upon the type of *service* in which they were to be used. These types of service have been designated as ML, MM and

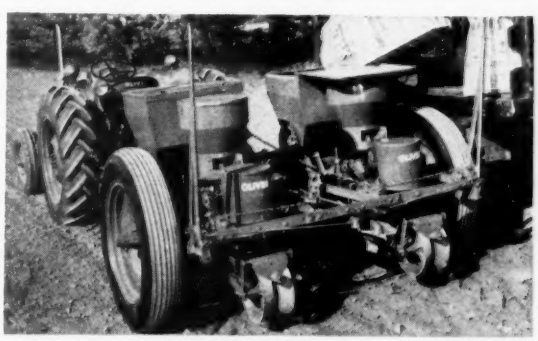


Courtesy of Ferguson Division, Massey-Harris-Ferguson, Inc.

Figure 27 – Greasing points and specially designed ball bearings may easily be seen on this mower driving unit.

Courtesy of New Idea

Figure 28 – Adjustable auger evens flow under light or heavy crop conditions; length of cut variable. Unit furnished with engine or PTO drive for tractors of more than 35 HP.



Courtesy of The Oliver Corporation

Figure 29 – With this fertilizer planter it is possible in a single operation to apply two different fertilizer formulae in four bands at two different levels in the soil.

TABLE III
LIMITING REQUIREMENTS FOR DIESEL FUEL OIL

Grade of Diesel Fuel Oil		No. 1-D A volatile distillate fuel oil for engines in service requiring frequent speed and load changes.	No. 2-D A distillate fuel oil of low volatility for engines in industrial and heavy mobile service.	No. 4-D A fuel oil for low and medium speed engines.
Flash Point, °F.	Min.	100 or legal	125 or legal	130 or legal
Pour Point, °F.	Max.	20	—	—
Water & Sediment % by volume	Max.	Trace	0.10	0.50
Carbon Residue on 10% Residuum, %	Max.	0.15	0.35	—
Ash, % by weight	Max.	0.01	0.02	0.10
Distillation Temperatures, °F.				
90% Point	Max.	—	675	—
End Point	Max.	625	—	—
Viscosity @ 100°F.	Min.	1.4	1.8 (32.0)	5.8 (45)
Kinematic, cs (or Saybolt Universal sec.)	Max.	—	5.8 (45)	26.4 (125)
Sulfur, % by wt.	Max.	0.50	1.0	2.0
Copper Strip Corrosion	Max.	No. 3	No. 3	—
Cetane Number	Min.	40	40	30

MS progressively for light, intermediate and severe service in gasoline engines. Diesel engine oils have been divided into two service classifications, DG and DS for normal and severe service, respectively. Each of these definitions has been explored more thoroughly in previous issues of magazine LUBRICATION and need not be detailed further here. It is interesting to note that oils which would now be recommended only for service ML and MM, were a short time ago the recommendations made for all gasoline engines under all conditions. Thinking regarding lubrication has changed, however, until now oils designated for service MS are recommended by many farm equipment manufacturers for general gasoline engine use.

These oils (for service MS) are known under a variety of names such as detergent oils, heavy duty oils, additive oils etc. The important part to remember about these oils is that they have been compounded by the refiner to keep an engine cleaner longer, to prevent bearing corrosion, to be nonfoaming and to have dispersant qualities which prevent the deposition of soot and other unwanted by-products in the engine. Many of these oils also have moderate rust preventive qualities and some EP characteristics that can reduce the rate of wear of the engine. They are slightly more expensive than the straight mineral oils but the benefits they provide are real and are reflected in longer, trouble free, engine life. In general, oils recommended for service MS have been compounded so that the addition of other specialty products is unwarranted. Reputable refiners expend large sums to develop products which incorporate all of the desirable properties enumerated above. It is possible for the refiner to incorporate at the time of manufacture

additives that laboratory and field tests have indicated to be beneficial. The practice of adding other agents in the field cannot be recommended.

Gear oils used in farm equipment have also changed considerably. Recommendations used to be for an inexpensive black oil; however, the use of precision, hardened, cut steel gears with their improved life but reduced size have gradually led manufacturers to the use of non-corrosive, mild, EP gear lubricants. These products have much greater load carrying ability and protect the gears under more severe conditions. There has also been a move to recommend lighter gear lubricants. Gear lubricants having viscosities in excess of 200 seconds Saybolt at 210°F. were often recommended. These viscosities have been reduced until now products falling within the SAE 90 viscosity limits of 75-120 seconds Saybolt at 210°F. are more common than any other viscosity recommendation.

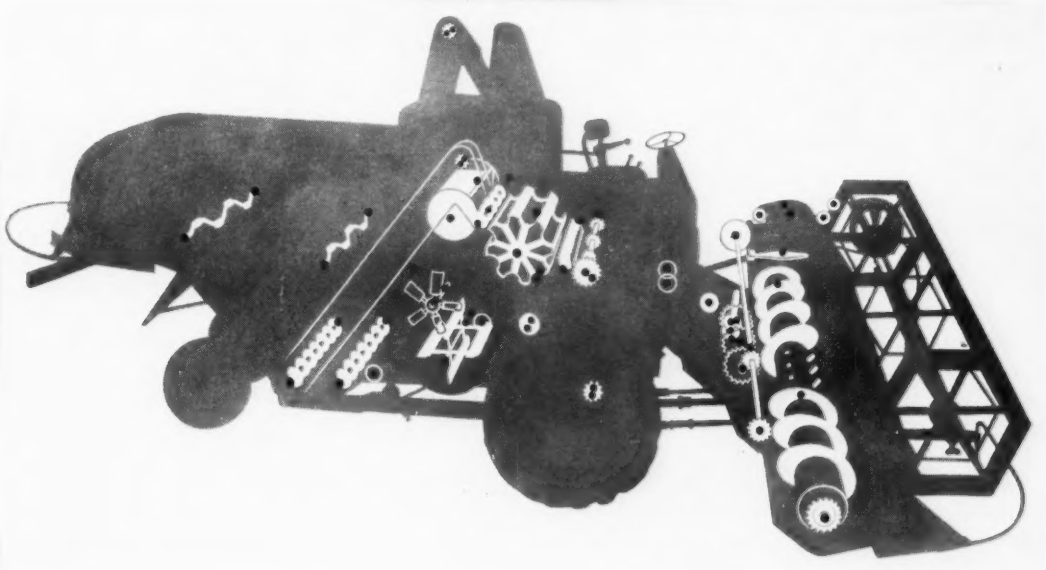
Hydraulic Oils

Due to the wide variation in hydraulic pumps that can be employed, recommendations for hydraulic oils vary considerably. Products having a viscosity of approximately 175 seconds Saybolt at 100°F. have proven very satisfactory. Three types of products may be recommended; (1) a straight mineral oil of a given viscosity, (2) an oil of the same viscosity which has been inhibited to give protection against rust and oxidation, or (3) an SAE 10 motor oil designed for use in service MS. The latter two oils have proven much more satisfactory than straight mineral oils where there is a tight system and leakage is no factor. SAE 10 motor oils can be recommended for the hydraulic system since these oils are in the appropriate viscosity range, have some rust preventive properties, and are readily available.

Greases

Modern greases are a far cry from the early grease products used on the farm. Axle grease did have the advantage of being relatively cheap and widely available. However, the advent and use of precision ball and roller bearings led to the use of higher quality products which have now largely supplanted the old type axle grease. It is recognized that cup greases still are widely used but with the increasing use of anti-friction bearings, it would appear that the cup grease days are numbered. Greases designed for use in anti-friction bearings may also be used for general purpose grease lubrication. Ball and roller bearing greases for general purpose use have long been prepared from soda-soap and they have high melting points and impart moderate rust protection, even though their soaps are somewhat water soluble.

The ability of a water soluble grease to give rust protection is one of the properties of greases that is not well understood. In the case of water soluble greases, an emulsion is formed when water is introduced. In this emulsion the water is enclosed within an oil film so that it cannot come in contact with the metal. Lubricating properties remain unim-



Courtesy of Massey-Harris

Figure 30 — Sealed bearings may eliminate up to 80% of normal greasing points. These bearings are designed to reduce time spent on lubricating equipment.

paired when such an emulsion is formed. These greases may however be washed slowly away in the presence of large amounts of water, so that frequent relubrication is advisable when extremely wet conditions are encountered. When water is brought in contact with a water insoluble grease, it is neither emulsified nor dissolved within the soap but remains separated in the form of globules. These globules upon coming in contact with the shaft lead to the formation of rust during periods of inactivity.

Usage of lithium soap greases has increased materially over the past few years. These greases are water insoluble, have relatively high melting points, and have good low temperature performance. They can be handled in grease guns under low temperatures more easily than can the soda-soap products. They are satisfactory ball and roller bearing greases and may be used as the regular chassis lubricant.

Simplification

A simplified lubrication plan is as desirable on the farm as elsewhere, and such a program can be put into effect where present day lubricants are involved. Four products of good quality can handle most requirements — an engine oil (for service MS), a mild EP gear lubricant, a hydraulic oil, and a general purpose ball and roller bearing grease. One additional product for the lubrication of open gears may be desirable in some cases. Such simplification is desirable since it reduces the inventory that must be carried by the farmer, and with fewer products, the chances of misapplication are greatly reduced.

With finer equipment the problem of maintenance becomes of greater importance. It is here that the operator of the equipment must join the manufacturer and the oil supplier and become the third member of the team. When equipment is in constant use, regular maintenance and relubrication at the specified intervals with high quality products are necessary to secure the performance and life which had been built in by the manufacturer. During the periods of inactivity and storage, products developed specifically to protect equipment from rust and corrosion prove their worth economically. Products such as engine preservative oils and rust proof compounds, under the impetus of war, made great strides forward quality-wise and are now widely distributed. They should be used to protect the equipment and the investment.

There is a definite move in the agricultural equipment field to recommend the use of premium petroleum products. This is a relatively new trend in that the recommendation of a high quality petroleum product in the past often implied a "fussy" piece of equipment. It is now being more widely recognized that recommendations of premium products are to the owner's advantage. The use of premium quality petroleum products reflects the fact that farm machinery is now precision equipment, designed and manufactured for high performance under heavy duty conditions over a long period of time.

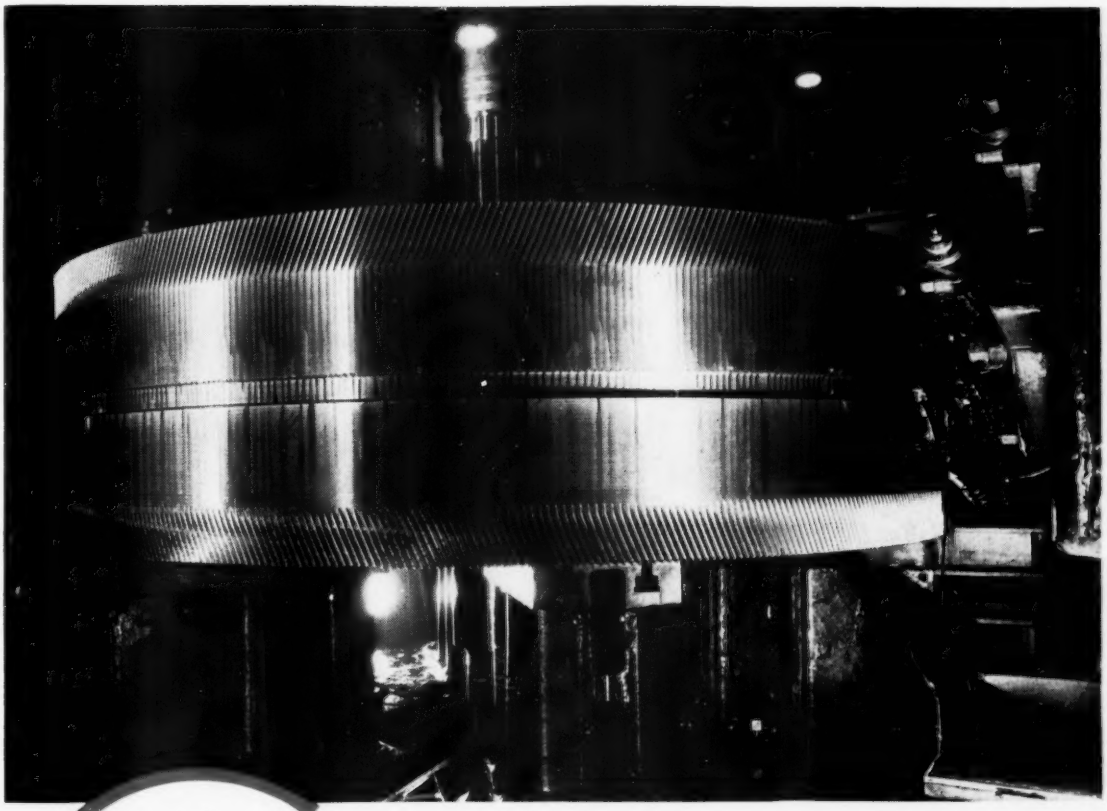
COOPERATION

Cooperation between individuals or manufacturing members of an industry within any broad area of interest generally results in joint benefits. Tangible examples of such benefits are easily found within the farm industry. Cooperation first occurred in relation to safety devices. The successful application of such safety devices led in turn to consideration of other areas of design and manufacture in which cooperative thinking was and is mutually beneficial, to the owner as well as the various manufacturers. Over a period of years this cooperation has led to the establishment of standards acceptable to the American Society of Agricultural Engineers and the Society of Automotive Engineers. These standards cover such widely diverse subjects as spark arresters, testing codes, tractor draw bars, tractor and implement disc wheels, tractor belt and pulley speeds and pulley widths, application of hydraulic remote controls, tractor power take-offs, power take-offs drives and safety lamp brackets. It is anticipated that continuation of this cooperation will lead to even further benefits.

TRENDS

The many developments made by this dynamic industry in the past can lead only to the conclusion that many new developments will be forthcoming in the future. To crystal gaze, more use may be made of: higher compression gasoline engines, Diesel engines, turbine engines, automatic transmissions, improved metallurgy, cut steel gears, more versatile hydraulic systems, sealed anti-friction bearings. While these developments are largely related to the tractor and/or implement, other equipment has also been improved or developed. Examples might include dryers, silo unloaders, automatic cattle feeders, milk handling equipment, barn cleaners, etc. In a nutshell it is believed that automation can and will find increasing use on the farm.

Printed in U. S. A. by
Salley & Collins, Inc.
305 East 45th Street
New York 17, N. Y.



THE TOUGH JOBS GO TO TEXACO

HERE'S JUST ONE example. Cutting teeth on this 15-foot diameter gear calls for extreme accuracy. On the finish cut—a 72-hour, non-stop operation—the two cutting tools *must not change dimensions by as much as 1/10,000th of an inch!* If they do, the giant gear will have to be re-cut.

One of the famous Texaco cutting oils is relied on here to keep the tools sharp, assure accuracy and fine surface finish.

Whatever you make or wherever you're located . . . Texaco Industrial Lubricants and the know-how of Texaco Lubrication Engineering Service can help you turn out your product faster, better, and at lower cost.

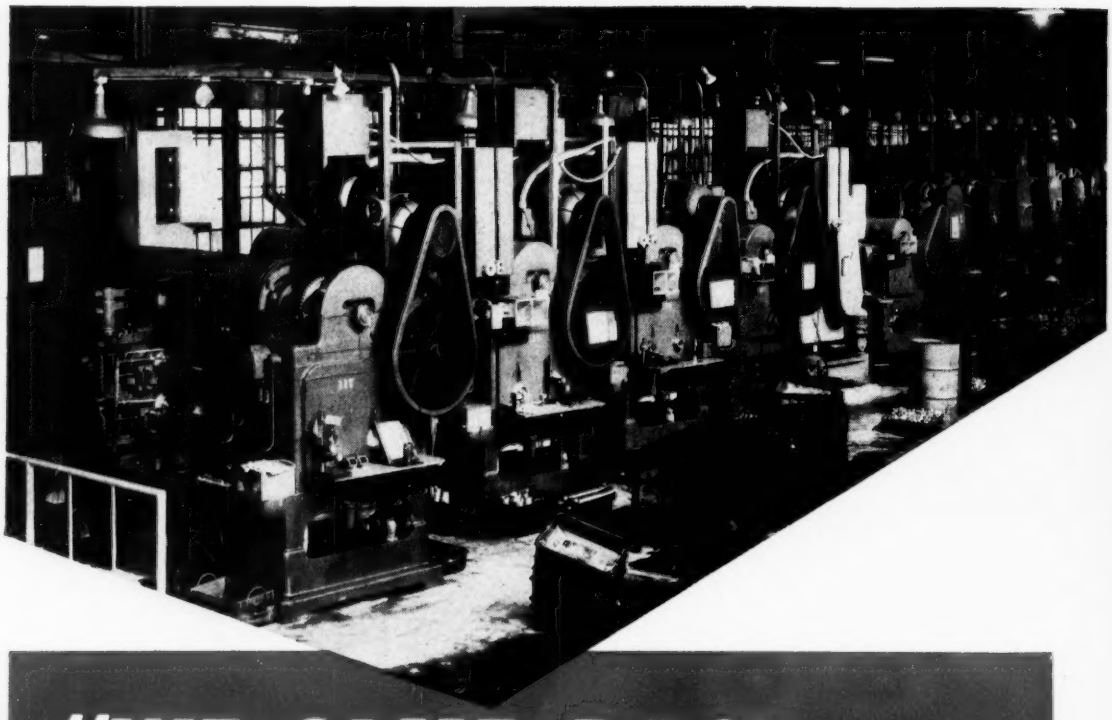
Let a Texaco Lubrication Engineer give you specific details. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N.Y.

TEXACO

REG T M

TEXACO Lubricants, Fuels and Lubrication Engineering Service



"WE CAME BACK TO TEXACO FAST"

Reports Boaring Manufacturer (Name on Request)

HERE'S A GOOD example of how Texaco quality and the skill of Texaco Lubrication Engineering Service help manufacturers keep their production up and unit costs down.

About three years ago, the plant shown made a direct comparison between *Texaco Cleartex Oil* and another brand of dual-purpose oil in their automatics. This other oil not only discolored and oxidized copper but quickly created a very dirty condition on the lubricating sides of the machines. So, says the report:

"We came back to Texaco—fast! Within a matter of days . . . the lube sides of the automatics were clean as a whistle again, and we have had no more trouble since that time."

A Texaco Lubrication Engineer will gladly help you prove to yourself that Texaco can help you produce a better product at a lower cost. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N.Y.

THE TEXAS COMPANY • TEXACO PRODUCTS • DIVISION OFFICES

ATLANTA, GA.....864 W. Peachtree St., N.W.
BOSTON 16, MASS......20 Providence Street
BUFFALO 9, N. Y......742 Delaware Avenue
BUTTE, MONT......220 North Alaska Street
CHICAGO 4, ILL.....332 So. Michigan Avenue
DALLAS 2, TEX......311 South Akard Street
DENVER 3, COLO......1570 Grant Street

TEXACO

HOUSTON 2, TEX......720 San Jacinto Street
INDIANAPOLIS 1, IND., 3521 E. Michigan Street
LOS ANGELES 15, CAL....929 South Broadway
MINNEAPOLIS 3, MINN....1730 Clifton Place
NEW ORLEANS 16, LA......1501 Canal Street
NEW YORK 17, N. Y......205 East 42nd Street
NORFOLK 10, VA...Olney Rd. & Granby Street

SEATTLE 1, WASH......1511 Third Avenue

Texaco Petroleum Products are manufactured and distributed in Canada by McColl-Frontenac Oil Company Limited.